Ranking Multi-attribute Entities: A Possible Inexpensive Alternative To AHP

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Purpose :

There are many situations where we wish to compare multi-attribute entities, such as buying a car, choosing a college, evaluating employees and customers, or even choosing a date.

There is a method for this sort of comparison called the Analytic Hierarchy Process, or AHP. This method allows for multiple alternatives to a required choice to be evaluated and ranked by multiple criteria. But when there are many alternatives, simply preparing the input becomes an enormous chore since one must make a pair-wise comparison of each alternative with every other alternative for each criterion.

The proposed method may offer an alternative to AHP that is vastly simpler and–perhaps–equally good. (Resolving this issue can be done relatively quickly, but not quickly enough for today's presentation.)

Suppose a woman wants to choose a date from among 26 men. She will rate them on the following criteria: income, looks, height, weight, IQ, health, and age. These particular attributes are chosen because they will, collectively, illustrate all the different scales, as well as the necessity of handling outliers. This young lady will also indicate her ideal values for each criterion and supply a weight to each. All data were randomly generated.

Here is the original data:

scale type	4	1	4	5	3	2	4
how much better	50%		10%	25%			50%
Perfect-->	$200,000	10	6-2	180	120	0	40
Weight-->	150%	150%	100%	100%	150%	100%	100%
Member	Income	Looks	Height	Weight	IQ	Sick Days	Age
Al	$34,600	7	5-6	155	95	4	61
Bill	$77,400	7	6-3	282	151	5	53
Curly	$45,500	10	5-8	163	116	0	63
Dave	$39,400	8	5-11	163	97	3	61
Ed	$66,200	7	5-4	195	100	3	31
Frank	$85,100	7	5-7	191	95	0	33
George	$68,500	1	5-11	175	91	5	43
Hal	$52,400	4	5-11	187	125	0	63
Izzy	$65,300	7	5-9	188	113	0	30
Jack	$32,400	6	6-1	200	143	2	46
Karl	$67,900	4	6-0	195	127	0	43
Larry	$49,400	6	5-10	169	153	0	37
Mo	$67,600	5	5-9	156	103	0	33
Ned	$51,400	2	6-2	170	132	0	41
Ozzy	$75,400	1	6-4	156	105	3	50
Paul	$49,200	6	5-9	177	128	4	42
Quentin	$87,600	10	6-0	189	137	0	41
Ron	$556,800	2	6-4	185	131	0	61
Sam	$42,100	2	5-7	179	120	0	61
Tom	$33,900	3	6-1	189	156	0	33
Umberto	$35,800	7	6-5	197	114	0	51
Vince	$37,300	10	6-0	167	87	0	64
Walt	$66,900	2	5-7	153	109	0	54
Xander	$85,500	2	6-1	178	130	0	65
Yves	$84,300	10	5-7	175	134	4	45
Zachary	$648,700	9	5-11	275	98	0	34

The first line in the table declares the "scale type." Here are the kinds of scales that could be encountered:

1.High score is good (e.g., test scores, gas mileage).
2. Low score is good (errors, costs).
3. Central Optimum, higher or lower is equally bad (blood pressure).
4. Central Optimum, higher is better than lower ($100 more is better than $100 less).
5. Central Optimum, lower is better than higher (10 lbs underweight is better than 10 lbs overweight).

Ranking Multi-attribute Entities Method:

There are two steps involved in comparing multi-attribute entities. The first is to normalize all the data of each attribute for each entity, so that numerically disparate attribute values can be compared on the same 0-100 scale. The second step is to calculate the "distance" of each entity from a user defined ideal.

So let's start by briefly explaining the steps…

1-Normalizing Data:

After allocating each attribute to one of the five scales, we normalize all the data using scale-specific formulas which are relative rather than absolute. When the scores are normalized to values between"0" and "100" (where "0"is worst and "100"is the best) we can compare disparate raw values on an equal footing.

Dealing with outliers:

A consequence of outliers is that a single outlier will result in all other entities having unfairly low scores. An example is "salary." If one person has an unusually large salary, everybody else will have a normalized score of close to zero since normalization is relative. Outliers can be handled in two ways, either "statistically" or by "User's choice."

Weighting:

The user might consider one attribute more important than another. We weight normalized scores by pushing above-average attribute scores upward and below-average attribute scores downward. The lady in this example has chosen income, looks, and IQ to be 1.5 times more important than the other attributes.

Now we have to find the alternative which is the "closest" to the ideal.

2-Ranking Multi-attribute Entities:

After doing all the previous steps we now have the final result which is in the "Total" column in the table below. This gives the final rank of the alternatives on a scale 0-100 and considering all the lady's preferences. As we said before, 100 is the best and 0 is the worst. In this example Quentin is the best choice.

Ladies – do you agree?

Member	Income	Looks	Height	Weight	IQ	Sick Days	Age	Total	Rank
Al	$34,600	7	5-6	155	95	4	61	1.2	25
Bill	$77,400	7	6-3	282	151	5	53	0	26
Curly	$45,500	10	5-8	163	116	0	63	67.6	6
Dave	$39,400	8	5-11	163	97	3	61	30.6	22
Ed	$66,200	7	5-4	195	100	3	31	16.4	23
Frank	$85,100	7	5-7	191	95	0	33	50.1	17
George	$68,500	1	5-11	175	91	5	43	8.1	24
Hal	$52,400	4	5-11	187	125	0	63	54.1	12
Izzy	$65,300	7	5-9	188	113	0	30	73.4	5
Jack	$32,400	6	6-1	200	143	2	46	50.3	16
Karl	$67,900	4	6-0	195	127	0	43	73.6	4
Larry	$49,400	6	5-10	169	153	0	37	53.8	13
Mo	$67,600	5	5-9	156	103	0	33	51.7	14
Ned	$51,400	2	6-2	170	132	0	41	74	3
Ozzy	$75,400	1	6-4	156	105	3	50	35	21
Paul	$49,200	6	5-9	177	128	4	42	54.6	10
Quentin	$87,600	10	6-0	189	137	0	41	100	**1**
Ron	$556,800	2	6-4	185	131	0	61	66.8	7
Sam	$42,100	2	5-7	179	120	0	61	41.2	18
Tom	$33,900	3	6-1	189	156	0	33	36.6	20
Umberto	$35,800	7	6-5	197	114	0	51	78.7	2
Vince	$37,300	10	6-0	167	87	0	64	51.2	15
Walt	$66,900	2	5-7	153	109	0	54	37.2	19
Xander	$85,500	2	6-1	178	130	0	65	57.3	8
Yves	$84,300	10	5-7	175	134	4	45	55.8	9
Zachary	$648,700	9	5-11	275	98	0	34	54.5	11